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Colour Ball Based on Microcontroller as A Educational Games Tools for Early Chilhood Learning

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Abstract
The use of technology for educational game tools or known as APE in early childhood still needs to be developed. This research aims to develop technology-based educational game tools for early childhood learning. Apart from that, it also aims to ensure that children understand earlier about using technology wisely and purposefully. APE Color Ball is designed in such a way that children will be able to get many benefits from one activity. This type of research is development research. The subjects involved as samples were teachers and students. This research chose the ADDIE (Analysis, Design, Development, Implementation, Evaluation) method to achieve the targeted objectives. The instruments used in this research were validation sheets, questionnaires and observation sheets. Through research activities and data analysis, it was found that Color Ball is suitable for use as a learning medium, in this case it functions as an APE for Kindergarten Class A. Based on observations with teachers and students of Kindergarten Class A, in One time learning activity using Color Ball students can get three benefits at once, namely motor activity, color recognition and introduction to simple English vocabulary. This benefit is very important to support children's development, especially in the current era of technological advances.

Keywords: *educational games tools; arduino colour ball; microcontroller*

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Introduction

After the COVID-19 pandemic era in recent years, it has had an impact on the education sector. Learning activities during the pandemic era were carried out online by utilizing various types of information technology. Even though it is currently being implemented offline again, the involvement of technology continues to colour learning and teaching activities

The involvement of this technology does not only apply to learning at the secondary and higher education levels but also to lower levels such as early childhood education. Early Childhood Education more commonly known as _preschool is early education for children from 0 to 6 years old (Kementerian Pendidikan dan Kebudayaan, 2023). Early childhood education starts from the family which is then continued in a wider environment, namely play groups or called KB. Furthermore, children are also introduced to formal education, in this case, kindergarten or kindergarten. It is very important to optimize support for early childhood education, considering that growth and development at an early age are reaching an optimal process (Pangarti & Yaswinda, 2023)

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Based on the Law on the National Education System Article 28 of 2003, early childhood education is held before the basic education level. Early childhood education on formal channels in the form of Raudatul Athfal (RA) Kindergarten (TK) and other equivalent forms (Pemerintah Indonesia, 2003). Education in kindergarten is very beneficial for child development. Children will learn to socialize with a wider environment, children's abilities and creativity will be honed more and this is important as a provision for children to continue to basic education.

Early childhood education has learning outcomes regulated by the Curriculum Standards and Educational Assessment Agency of the Ministry of Education, Culture, Research and Technology and outlined in the PAUD CP-ATP. In CP-ATP PAUD there are learning outcomes based on elements, where children demonstrate initial abilities to use and engineer technology and to search for information, ideas and skills safely and responsibly. One example of a learning objective is for children to use technology safely and responsibly, both independently and in groups. However, based on the results of observations, learning outcomes regarding technology exploration have not been achieved optimally (Badan Standard Kurikulum dan Asesmen Pendidikan, 2022).

Talking further about education at the kindergarten level, the use of technology in learning activities in kindergarten has been carried out a lot but it can be said that it is not optimal. In learning activities, technology is used as an aid to learning media, but it has not been used optimally as a learning resource (Prastyaningrum et al., 2023). The use of technology in learning activities so far is in the form of using laptops and computers, projectors, the internet, audio-video, and making presentations to children. In this case, the child can be said to have less direct interaction with the media.

Apart from the conditions mentioned above, limited human resources, in this case, preschool teachers, are also one of the factors causing the less than optimal use of technology in the kindergarten environment. During the Covid-19 pandemic some time ago, various training related to increasing the ability to use technology had been carried out, for example, training on making animated video images, training on literacy of learning resources and materials on the internet and training on making information technology-based learning media. (Hapsari et al., 2018; Hardiyanti et al., 2020; Syahroni, 2020). The benefits obtained from several training activities that have been carried out are the increased ability of kindergarten teachers in mastering information technology. This mastery of information technology can later be used by preschool teachers to create instructional media to support teaching and learning activities in schools.

Learning media is very important in teaching and learning activities (Makapedua et al., 2021). Selection of appropriate media will help students to better understand the material. The media chosen for the kindergarten level is media that can collaborate learning and playing activities. This is because learning activities for the preschool level are carried out in a cheerful atmosphere so that children's learning activities must be packaged in such a way as play activities. In other words, children's play activities must contain educational value that aims to stimulate children's development (Handayani, 2020; Veronica, 2018).

In learning activities in kindergarten the use of technology can be done more broadly, for example by using technology-based Educational Games Tools. Based on the results of the interviews, so far the Educational Games Tools in Kindergarten is still limited to conventional Educational Games Tools. For example, in the form of balls, wooden blocks, pictures and several other types of Educational Games Tools.

The use of technology-based Educational Games Tools is expected to attract Kindergarten students' interest, increase their creativity and curiosity about games that apply technology but not in the form of smartphones or other gadget models. It is undeniable that kindergarten students' interest in gadgets is very high. In 2022, the Central Bureau of Statistics noted that almost half of Indonesia's early childhood children are able to use cellphones and access the internet. This will have a negative impact if wise assistance is not carried out. With

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the existence of technology-based Educational Games Tools, it is hoped that children's interest in smartphones can be diverted.

Educational Game Tools can be made using microcontroller technology. Several Educational games tools that have been created and used by kindergarten schools are English Fun With Arduino Uno. This Educational Games Tools is used to introduce students to some vocabulary in English, for example body parts and simple verbs (Prastyaningrum et al., 2022). This limitation of Educational Games Tools, students are still not fully involved, so it really needs to be developed again. Apart from that, there is also Educational Games Tools that uses Arduino and RFID cards on marine animal recognition media (Wibowo & Wahyusari, 2022). Another type of Educational games Tools uses the Arduino Nano and Reed Switch for rote and prayer educational games. This type of Educational Games Tools is in the form of a dollhouse educational game kit that can produce the sound of daily prayers (Vivianti & Ratnawati, 2019).

Based on this, we developed an Educational Games Tools on the introduction of red, blue and yellow in English. Educational Games Tools is equipped with pocket books and manual books to support the learning process. The Educational Games Tools that we designed and built uses a microcontroller and we named it Colour Ball.

The way it works is quite simple, where the child puts the ball into the hole that has been equipped with red, blue and green senders. If the child puts the ball in the same colour as the Colour Ball, the response will be "You are right". However, if it is not appropriate, you will get the response "You are wrong, try again". In order to support children's English knowledge, we complete this Educational Games Tools with a pocket book about objects in the environment that have the same colour as the colours they have learned.

Methodology

This type of research is development research where the approach used is a mix method approach. Mix method research is research that combines qualitative and quantitative data collection and analysis methods in one study (Creswell, 1999). The steps for carrying out research are briefly shown in Figure 1.

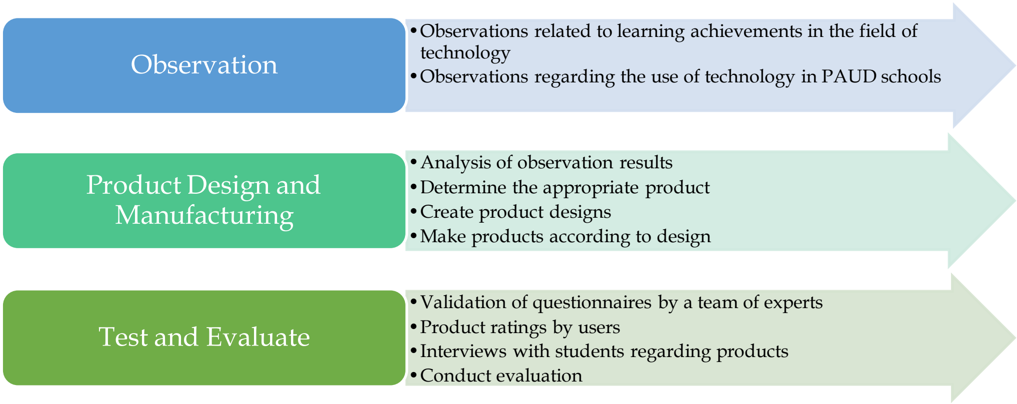

Figure 2. Steps for conducting research

This research uses the ADDIE method which includes Analysis, Design, Development, Implementation and Evaluation (Sasmito et al., 2021; Sugihartini & Yudiana, 2018). The stages of research using ADDIE are shown in Figure 2.

Based on the results of identifying problems related to the extent to which technology is used in learning activities, the solution we provide is to design a technology-based Educational Games Tools. We chose to use the Arduino Uno in the Educational Games Tools Colour Ball. The next step is the creation of the Educational Games Tools design followed by the realization of the design. In this design stage, we also compiled research instruments in the form of expert validation sheets and assessment sheets from respondents.

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The next step is to conduct an instrument validation test by a team of experts, followed by trials in schools to get responses from teachers and students as users. After that, the final stage is to evaluate the results we get. We process the data we get to find out what percentage of the validity of the media we make.

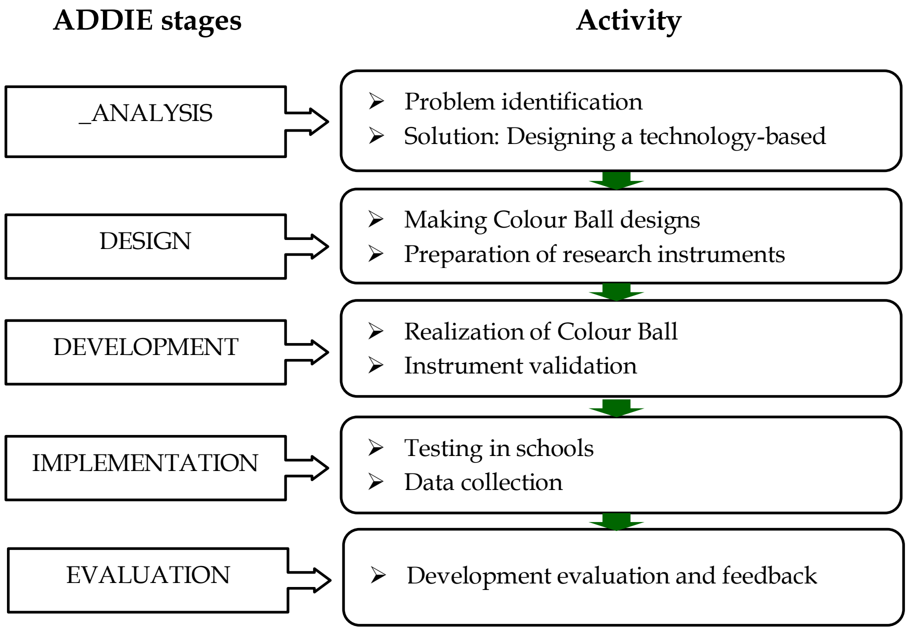

Figure 2. Research stages

The research instruments used in this research include validation questionnaire sheets, user assessment questionnaires and student observation sheets. The data we collected was obtained from the results of the expert team's assessment of the questionnaire that would be used, the results of assessments from kindergarten teachers and the results of observations of kindergarten students who were prospective media users. We analyzed the results of the questionnaire assessment from our expert team using the CVI approach (Baharuddin et al., 2020; Spoto et al., 2023). We analyzed the teacher's media assessment questionnaire using the TSEV (Total Score Empirical Validator) equation (Elmunsyah et al., 2018; Syafmen et al., 2021). The observation results were analyzed using a descriptive approach. This is because the data from observations is qualitative data.

Result and Discussion

In the results and discussion section, we will explain the results of the research that has been carried out. The discussion will be written based on the stages in the research method.

At this stage it is explained about how we make observations to identify existing problems. From the results of problem identification, we found the fact that the majority of the use of technology in learning activities in kindergarten is limited to the use of laptops, the internet, projectors and learning videos. The lack of use of technology in student Educational Games Tools at school is also one of our bases for developing the Colour Ball. Based on the identification results of the 26 schools that we observed, 69% of schools still have various problems in using technology in learning activities (Prastyaningrum et al., 2023). The cause of the less than optimal use of technology in learning is due to several factors, one of which is the lack of competence of educators in mastering information technology (Winarti et al., 2022). Problems related to the use of technology in learning for early childhood have been widely researched. Various learning media have also been designed and applied (Novitasari, 2019; Sholihatun et al., 2020). This includes the use of augmented reality live texturing technology for learning to draw (Dharmawan & Rahayu Setyaningsih, 2022). However, this research still

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has limitations in that children's exploration is not optimal. This is one of our considerations in developing Educational Games Tools. Where Educational Games Tools must be made as simple as possible so that teachers and students are easy to use.

At the design stage we design the Educational Games Tools to be made. Consideration of the tools and materials used as well as the completeness of the research instruments. The Educational Games Tools design is shown in Figure 3.

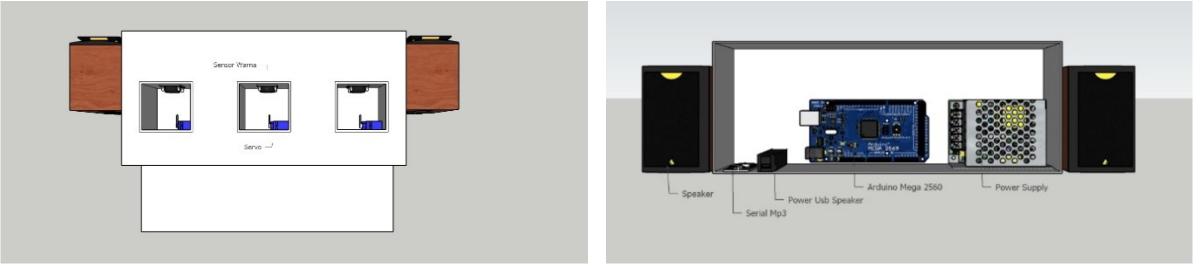

Figure 3. Design of Educational Games Tools Colour Ball

In addition to making the Educational Games Tools design, at this stage preparations were also made to complete the research instruments in the form of expert validation sheets and respondent assessment sheets.

We carry out the development phase by realizing the design that has been designed. This Educational Games Tools uses a colour sensor based on the Arduino Mega2560. This sensor is an electronic device used to recognize and process the colour of an object or surface. This system utilizes the Arduino Mega 2560 component as an operational brain, three tcs 3200 colour sensors to measure the intensity of light reflected by objects, a servo as a ball holder, and an Mp3 series to process sound signals, and speakers function to produce sound or sounds from audio signals. given by the Mp3 series.

The way the tool works starts with the colour sensor activating the lighting LED that illuminates the object. The light reflected by the object is then received by a colour sensor that measures the intensity of red, green and blue light. This light intensity data is sent to the Arduino Mega 2560, which then analyzes and processes the information. Based on the received data, Arduino Mega 2560 can identify the colour of an object by comparing it with a pre-programmed colour pattern. then the servo that holds the ball will drop so that the ball is in the lower shelter of the tool. Serial Mp3 will process the colour of the object and the speaker will issue the results, if the colour matches the place it will sound "you are right" if it is wrong it will sound "you are wrong, try again" (figure 4).

Figure 4. ***Colour Ball***

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At the development stage, instrument validation was also carried out consisting of lecturers and practitioners in the field of early childhood education. The instrument validators in this study were three people. Analysis of data validation results of experts using the Content Validity Index (CVI) (Puspitasari & Febrinita, 2021; Sugiharni, 2018). The validation results show that the mean i-CVI for the questionnaire validation consists of 4 aspects, namely instructions for use = 1.00; sentence clarity = 1.00; grammar = 1.00; media objective = 1.00. From this value it can be concluded that the developed questionnaire is feasible, relevant, and has a high validity value, so it is ready to be used for data collection.

Respondents from this study were five teachers of Early Childhood Education (Preschool) TK IT Nur Mujahidin and 48 students in class A. Respondents from teachers assessed Educational Games Toolsin terms of material and media, while for students we conducted observations and trials with the teacher and saw how they responded to this Educational Games Tools.

Based on the results of data analysis, the results are shown in Table 1. The results of the respondents' assessment indicate that the media is said to be suitable for use, with an average feasibility level of 81.25%. (Sugiyono, 2017). Details of the percentage of eligibility are shown in Table 1 and Table 2.

Table 1. Percentage of eligibility in terms of Educational Games Tools media

No	Rated Aspect	Prosentase	Information
1.	Operational ease	85%	Very Worth
2.	Media appeal	85%	Very Worth
3.	Communicative	85%	Very Worth
4	Usefulness returns	65%	Worth

Table 2. Percentage of eligibility in terms of Educational Games Tools media

No	Rated Aspect	Prosentase	Information
1.	Material suitability	80%	Worth
2.	Conformity with learning objectives	75%	Worth
3.	Conformity with the characteristics of the child	95%	Very Worth
4.	Understanding of English	80%	Worth

Based on Table 1, it appears that the reuse aspect has a lower percentage than the other three aspects. This is supported by the results of observations in the field that some or all of the Colour Ball cannot be reused for other learning materials. It is suggested that in the future it can be designed in such a way that the media can be reused for other materials.

Another thing that is also in the spotlight is suitability with learning objectives. It is recommended that the colour selection in Educational Games Tools be distinguished between primary and secondary colours. Early childhood will find it easier to identify primary colours as early learning (Hidayati & Saugi, 2020). Green and blue are colours that have a fairly high level of similarity, so it is sometimes difficult for children to tell the difference.

The use of technology in color recognition for young children has been researched before. The media form is interactive animation(Fitriyani et al., 2015; Purwaningsih, 2018; Rozi & Khomsatun, 2019). . The difference between these two media and Color Ball is that this media is in the form of application software, while color ball is a real object in 3D form. Apart from knowledge about colors, children can also hone their motor skills.

So far many educational game tools that are useful for supporting motor development have also been developed. Snakes and ladders game model to help gross motor development in children aged 4-5 years (Rismadani et al., 2022). Educational game tools with the theme of golf have also been developed to support fine motor development (Leli Fertiliana Dea et al., 2021). A part from these two types of media, there are also educational game tools using

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Microsoft PowerPoint (Muazzomi, 2017). Another form is the octopus pocket game model which is useful for stimulating their physical and motor development (Fitriyanti et al., 2023).

Another model that was also developed was the Webbed Model. In order to stimulate children's motor skills, plasticine was chosen as a learning medium ((Wati et al., 2014)). The difference between Color ball and this media is that there is a touch of technology in the media to support children's motoric development. Besides that, color ball also has advantages, where in one medium children will be able to learn three things at once, namely colors, motor skills and simple English.Colour Ball makes children involved in experimental activities directly related to colour identification and recognition of English. Studies show that experimental activities make it easier for children to gain new knowledge quickly (Maryani & Nofitasari, 2018). In one activity using the Colour Ball the children have been involved in three different activities. Namely sharpening children's motor skills, getting to know colours and learning simple English.

The results of the assessment or it can be said that the responses from the Class A students that we obtained from the observation activities are shown in Figure 4. Based on Figure 4, 85% of students showed quite high enthusiasm. This is evident from their desire to always try and explore objects around them that have red, blue and green colours.

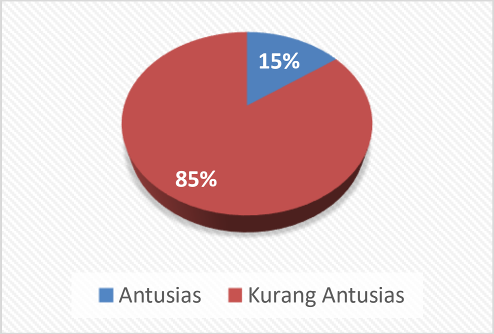

Figure 4. The percentage of Class A students' enthusiasm for the media

The final stage is evaluation which includes formative evaluation. At the formative evaluation stage data will be collected at each stage used for product improvement. Evaluation in the ADDIE model has been carried out step by step and the next product development trial is carried out.

The disadvantage of Color Ball is that environmental lighting has a big influence on the sensor reading results. Sometimes the blue color reads as green, so in the future it may be possible to condition the intensity of light entering the media to the minimum conditions. Another weakness that is still found in Color Ball is that this tool has dimensions that are only sufficient for small group learning, not classical.

Based on several limitations of the Color Ball, future research can further extend the length of the ball hole in the tool, so that the sensor has more accurate color readings. This is because if the hole is longer, the intensity of the light entering it will also be less. Apart from that, the second suggestion is to make color balls in a slightly larger size, so they can be used together.

Conclusion

Research conducted regarding the development of Educational Games Tools using a microcontroller was declared feasible for use. The process of learning and teaching at the early childhood education level applies collaborative play activities while learning. Colour Ball is able to involve three different activities during the activity. Colour Ball has limitations in the variety of colours used, so that in the future it can be redesigned using more varied colours.

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